

3M™ Specialty Fluids for Data Center Liquid Cooling Applications

3M™ Novec™ Engineered Fluids

3M™ Novec™ Engineered Fluids are designed to balance performance with favorable environmental and worker safety properties. They are available for a wide variety of applications, including heat transfer, cleaning, testing, and lubricant deposition. These fluids are not classified as flammable and are non-oil-based, low in toxicity, non-corrosive and have good material compatibility and thermal stability. Novec fluids also have low global warming potential (GWP) and zero ozone depletion potential (ODP).

3M™ Fluorinert™ Electronic Liquids

3M™ Fluorinert™ Electronic Liquids have set the industry standard for direct-contact electronics cooling for over 60 years. These extremely inert, fully-fluorinated liquids have exceptionally high dielectric strength and excellent material compatibility. Fluorinert liquids are clear, odorless, non-flammable, non-oil-based, low in toxicity, and non-corrosive and offer a wide temperature operating range and high thermal and chemical stability. Fluorinert liquids also have low dielectric constants making them ideal for single-phase and two-phase data center immersion cooling applications.

Properties	Unit	3M™ Novec™ Engineered Fluids		3M™ Fluorinert™ Electronic Liquids		
		Recommended products for direct to chip applications	Recommended products for two-phase liquid cooling applications	Recommended products for single-phase liquid cooling applications		
		7000	7100	FC-3284	FC-3283	FC-40
Boiling Point	°C	34	61	50	128	165
Pour Point	°C	-122	-135	-73	-65 ¹	-57
Molecular Weight	g/mol	200	250	299	521	650
Critical Temperature	°C	165	195	161	235	270
Critical Pressure	MPa	2.48	2.23	1.94	1.22	1.18
Vapor Pressure	kPa	65	27	35	1.4	0.29
Heat of Vaporization	kJ/kg	142	112	105	78	68
Liquid Density	kg/m ³	1400	1510	1710	1820	1855
Coefficient of Expansion	K ⁻¹	0.0022	0.0018	0.0016	0.0014	0.0012
Kinematic Viscosity	cSt	0.32	0.38	0.42	0.75	2.2
Absolute Viscosity	cP	0.45	0.58	0.64	1.4	4.1
Specific Heat	J/kg-K	1300	1183	1100	1100	1100
Surface Tension	mN/m	12.4	13.6	13	15	16
Solubility of Water in Fluid	ppm by weight	~60	95	14	7	<7
Dielectric Constant @ 1 kHz	-	7.4	7.4	1.9	1.9	1.9
Volume Resistivity	Ohm-cm	10 ⁸	10 ⁸	10 ¹⁵	10 ¹⁵	10 ¹⁵
Global Warming Potential ²	GWP	Low	Low	High	High	High
Flash Point ³	°C	None	None	None	None	None

Not for specification purposes. All values @ 25°C unless otherwise specified.

¹ Fluid is considered super cooled at this temperature. Talk to a Tech Service Engineer for more information.

² GWP-100 year ITH, CO₂ = 1.0, per IPCC 2013, with the exception of Novec 7100 fluid, which notes IPCC 2007.

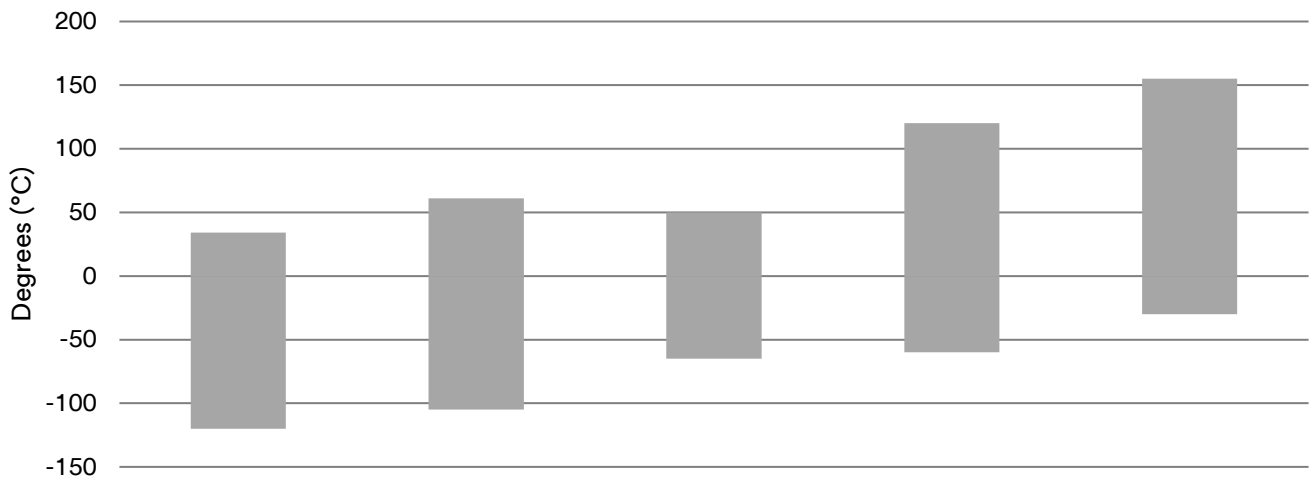
³ Per closed cup flash point test method.

Applications

For single-phase or two-phase data center liquid cooling (direct-to-chip and immersion cooling) applications, 3M recommends the use of the fluids listed above. It should be noted that the Novec fluids have high dielectric constants that may lead to insertion losses in high-frequency applications due to exposed circuit traces. These fluids have been used successfully in cryptocurrency mining applications and may potentially be used in other data center applications if modifications are made to the IT hardware to enable operation. Please consult 3M Technical Service for use of Novec fluids for immersion cooling.

Data Center Liquid Cooling Applications using 3M™ Novec™ Engineered Fluids and 3M™ Fluorinert™ Electronic Liquids

Recommended Operating Temperature Range



	Recommended for direct to chip applications	Recommended for two-phase liquid cooling applications		Recommended for single-phase liquid cooling applications	
	Novec 7000	Novec 7100	FC-3284	FC-3283	FC-40
Maximum ¹	34	61	50	120	155
Minimum ²	-120	-105	-65	-60	-30

¹ Maximum operating temperature for two-phase liquid cooling fluids is typically the boiling point. Higher temperatures are possible in pressurized systems. Typical values for single-phase liquid cooling fluids are 10°C below the boiling point.

² Typical values for single- and two-phase liquid cooling fluids are the measured or calculated temperature at 20-30 cSt viscosity.

To learn more about how 3M specialty fluids can help enable your data center liquid cooling applications, visit 3M.com/immersioncooling. To learn more about 3M™ Novec™ Engineered Fluids visit 3M.com/Novec.

Safety Data Sheet: Consult Safety Data Sheet before use.

Regulatory: For regulatory information about this product, contact your 3M representative.

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